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THE CRREL 2-INCH FRAZIL ICE SAMPLER.(U)
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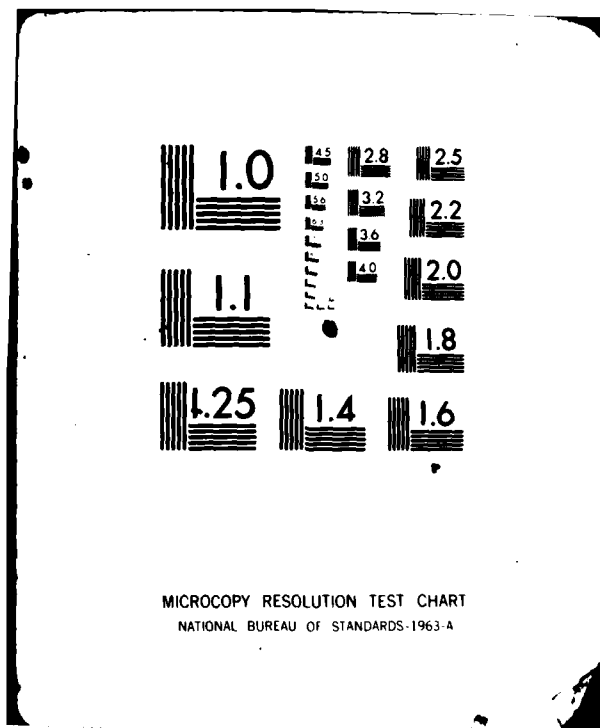
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John Rand

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PREFACE

The CRREL 2-inch frazil ice sampler was developed by John Rand, Mechanical Engineer, Engineering and Measurement Services Branch, Technical Services Division, U.S. Army Cold Regions Research and Engineering Laboratory. The development effort was undertaken for Stephen Ackley of CRREL under National Science Foundation Interagency Agreement NSF-DPP-24528. This report was technically reviewed by Mr. Ackley and Dr. Anthony Gow.

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THE CRREL 2-INCH FRAZIL ICE SAMPLER

John Rand

BACKGROUND

In the past, obtaining frazil ice samples in situ has been a troublesome task. Either the sampler was too bulky or awkward to operate or the seal at the bottom of the collection tube was not liquid-tight. Conventional frazil ice samplers are hollow cylindrical devices that allow the sample to pass into the collection tube through an opening in the bottom. Once the device is lowered to the desired depth, the sample is collected by closing the bottom of the tube and raising the entire unit to the surface. In other models the top of the tube closes off, preventing fluid replacement through the top opening. These samplers are pulled quickly upward to place the sample in a container. In some cases divers obtain samples directly, entering the water through large holes chopped in the ice.

OBJECTIVE

The objective of this project was to design a device for obtaining undisturbed samples of frazil ice using a cylindrical tube with a liquid-tight seal at the bottom to prevent the loss of frazil ice and water. The sampling device had to be designed to meet the following requirements:

1. The sampler had to be capable of passing through the 2 1/4-in.-diameter hole made by a CRREL 2 1/4-in. ice thickness auger.
2. The collection tube had to be made of a clear material to permit observations of the sample before removal from the tube.
3. The sample collected had to be at least 1 m long.
4. The design had to permit the mating of two or more tubes to obtain multiple 1-m samples.
5. Lightweight extension rods were required for lowering the sampler to the desired depth.
6. A valve assembly located at the bottom of the sampler had to allow the frazil ice to enter the sampler, yet provide a liquid-tight seal when the valve was closed.
7. The sampler had to be able to punch rather than rotate its way through the frazil to obtain samples.

DESCRIPTION

The frazil ice sampler (Fig. 1 and 2) is an open-ended tube constructed of transparent material. The top of the tube is fitted with an adapter for attaching extension rods used to raise and lower the sampler. A valve assembly is attached at the bottom of the open-ended tube. A string extends from the valve assembly to the surface. The valve is closed by pulling this string; constant pressure on the string is essential to keep the valve closed. To punch or cut through the frazil ice, a sharp shoe is attached to the bottom of the valve assembly.

The top component of the sampler, the stainless steel top connector (Fig. 3), provides the capability of attaching the extension rods. Water flows freely through the opening in this assembly. The stainless steel nipple provides the means for attaching the top connector to the sample tube. It also allows additional lengths of sample tube to be attached to increase the sample length. The sample tube is constructed of transparent material to allow visual examination of the sample prior to storage. Lexan

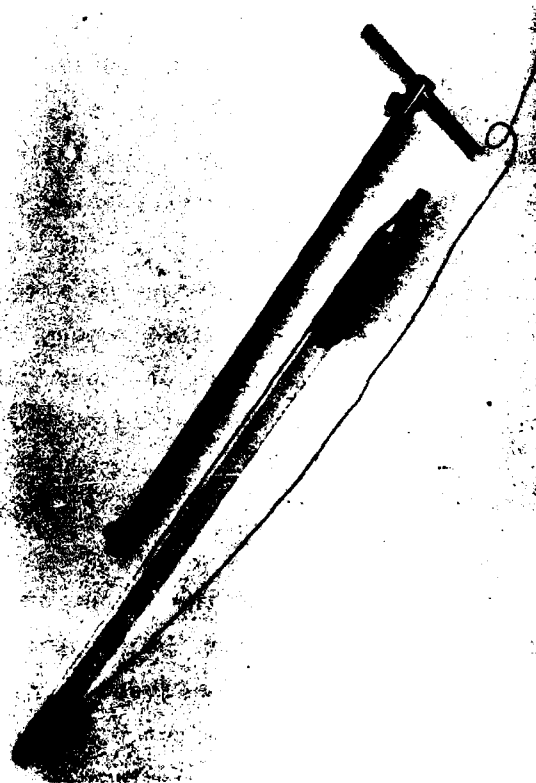
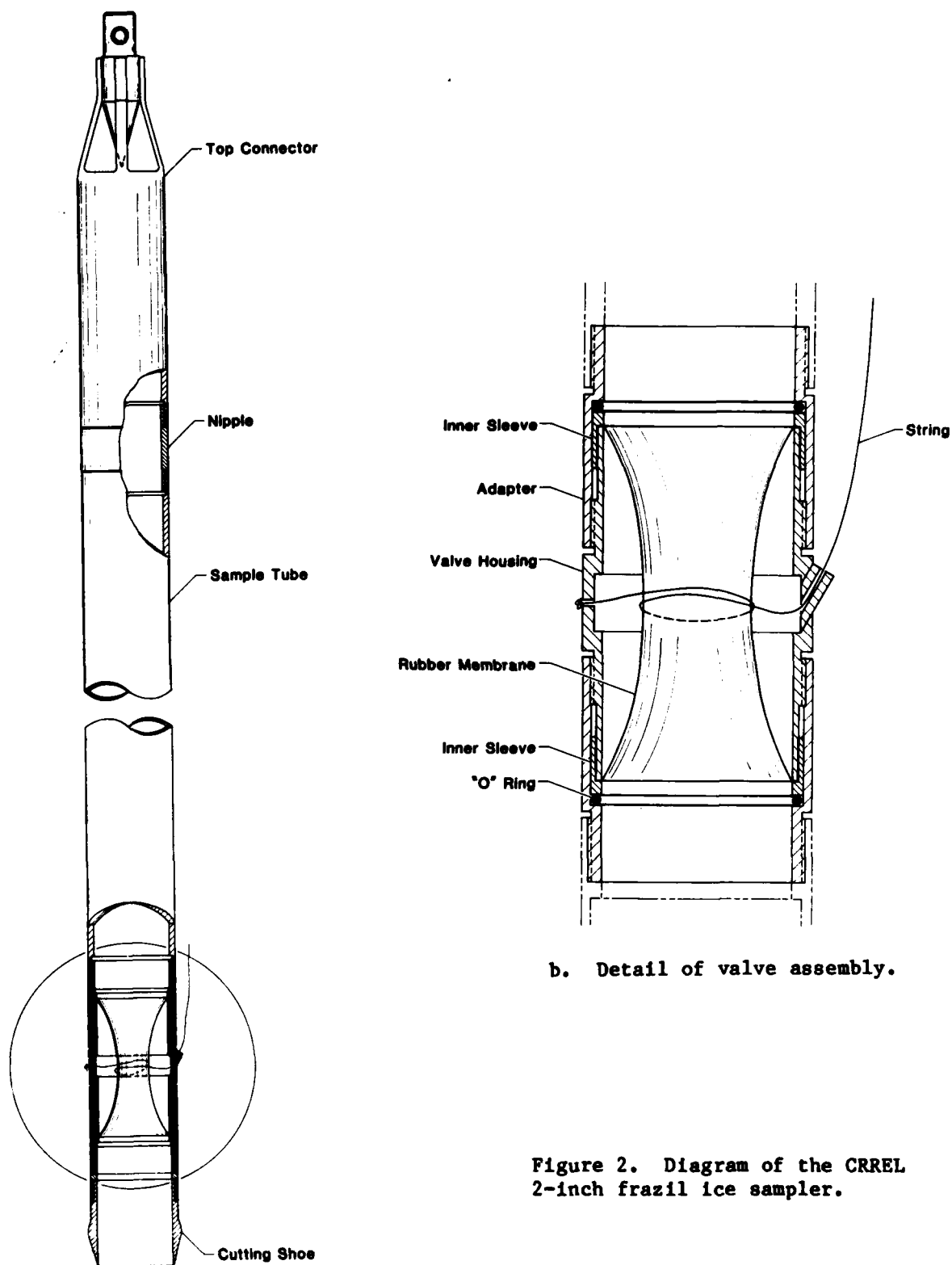


Figure 1. CRREL 2-inch frazil ice sampler.



a. Vertical cross section.
Value assembly is circled.

b. Detail of valve assembly.

Figure 2. Diagram of the CRREL
2-inch frazil ice sampler.



Figure 3. Top connector. Water passes freely through the opening.

tubing is recommended for this purpose. The length of the sample tube can vary according to the length of sample needed. The tube illustrated is 1 m long.

The valve assembly (Fig. 4 and 5) uses two valve adapters. The brass valve adapter provides the threaded connector for attaching the bottom of the sample tube. The bottom valve adapter connects to the shoe. The brass inner sleeve is a ring that slides over the valve housing. The function of this sleeve is to fasten the rubber membrane to the valve housing. When the valve adapter is screwed on the valve housing, an O-ring provides a clamping force between the inner sleeve, the rubber membrane, and the valve housing. The rubber membrane is attached at both ends as described.

The string, which enters the valve housing through the access hole, is looped around the outside of the rubber membrane and tied to a hole 180° from the access hole (Fig. 6). The string actuates the valve assembly. When the string is pulled, the rubber membrane (Fig. 7) constricts until

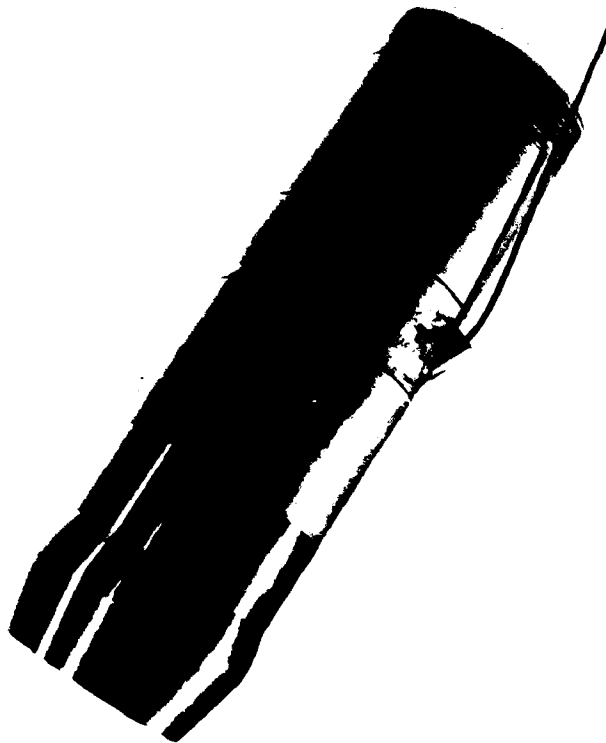


Figure 4. Valve assembly.

there is a liquid-tight seal at the valve. Constant pressure must be maintained on the string while the sampler is removed from the sampling medium. Releasing tension on the string allows the sample to be removed from the sampler.

The bottom valve adapter provides the connection for the cutting shoe. The shape of the stainless steel shoe can be varied according to need. The shape shown in Figure 2 is used for punching through layers of frazil ice. The sample passes up through the shoe into the sampler while material external to the shoe passes outside the sampler.

COMMENTS ON INITIAL USE

Mr. Stephen Ackley and Dr. Anthony Gow, both of CRREL, used the sampler for the first time in ice floes in the Weddell Sea off Antarctica in austral summer 1980-81. Unfortunately, in the area they worked in, they did not encounter frazil ice; however, the sampler was used periodically to obtain water samples.

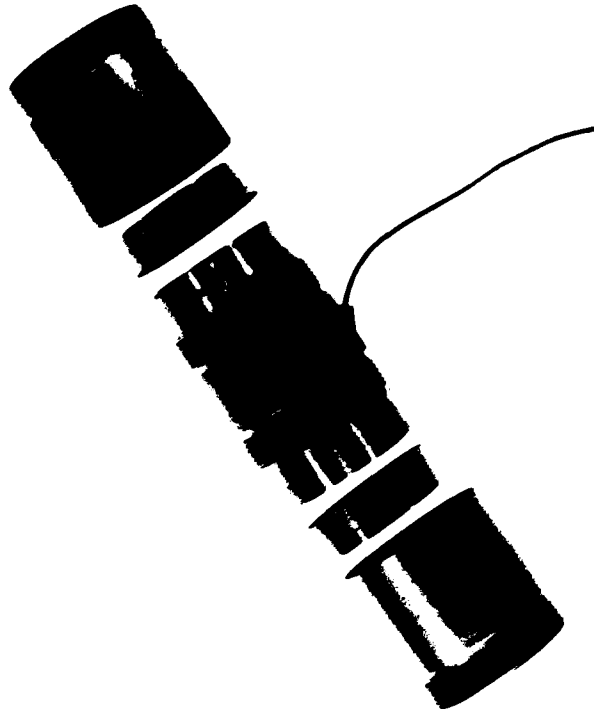


Figure 5. Components of the valve assembly.

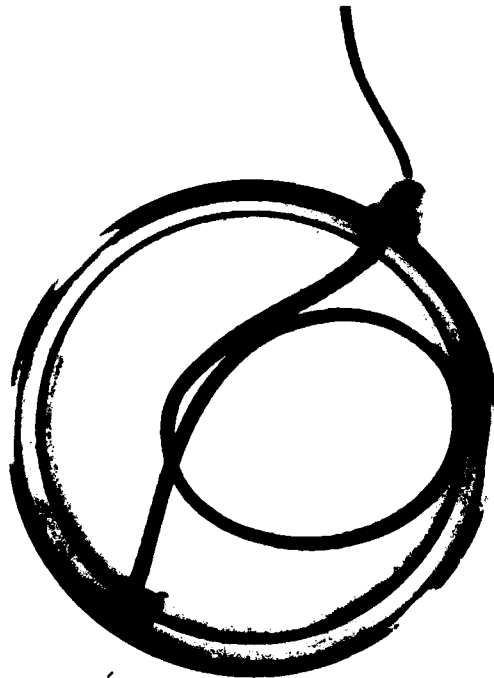


Figure 6. End view of the valve housing with the string coiled inside the valve.



Figure 7. Rubber membrane partially closed.

As a result of their experiences several changes to the initial sampler were made. These changes, along with advice to the potential user of this sampler, are presented below.

1. The sample tubes cannot withstand abuse. Two acrylic sample tubes were damaged on this trip. One that was standing vertically in a corner of the ship fell to the floor when the ship rolled, breaking one of the threaded ends of the tube. The second tube was broken when a SIPRE auger was accidentally placed on top of it in a sled. The plexiglass tubes have been replaced with Lexan tubes. Although Lexan is less brittle, the tubes are still fragile, and proper storage is important.

2. Cleaning of the sampler's components is very important if it is used in a salt environment. The components, particularly the extension pins and the valve assembly, should be flushed with fresh water after each period of use.

3. The valve assembly should be taken apart completely after each period of use. If the rubber membrane is not removed, it becomes difficult

to remove the inner sleeves. The membrane must be replaced each day if it is to function properly and provide a tight seal. This membrane is subject to rips and pinholes, which prevent the valve from properly sealing off the bottom of the sampler.

4. The string which activates the valve should be wound on a simple fishing reel to prevent tangling.

5. The shoe should be kept sharp at all times. Do not stand the sampler vertically on a hard surface for storage or assembly.

6. Two plexiglass caps are provided for each sample tube. This allows the sample to be stored until it can be transferred to another container. Spare O-rings, which aid in sealing the caps, are provided in the kit in case the original O-rings become damaged.

7. If a depth greater than 10 meters is desired, any rod (such as a SIPRE auger extension) can be used for this purpose.

